
CLAIMS

[Claim(s)]
[Claim 1]
The acceleration sensor characterized by having consisted of a regulation plate, a protective case, etc. which regulate a motion of the flexible section, the spindle section, and the spindle section of the acceleration-sensor component which consists of a housing, being the acceleration sensor to which the acceleration-sensor component and the terminal of a protective case were connected with the wire, having prepared the notching section in fields other than the four-corners section of a regulation plate, and preventing contact of a wire and a circuit pattern, and a regulation plate.
[Claim 2]
The acceleration sensor according to claim 1 characterized by fixing the four-corners section of a regulation plate through a spacer to the field in which the circuit pattern and terminal of a housing of an acceleration-sensor component are not formed.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]
This invention relates to the semi-conductor acceleration sensor for acceleration detection used for an automobile, the aircraft, a personal digital assistant device, a toy, etc.
[0002]
[Description of the Prior Art]
The acceleration sensor had regarded as acceleration the impact which that to air bag actuation were used and carried out the automobile collision. [many] By automobile, in order to measure the acceleration of the X-axis and a Y-axis, one shaft or a biaxial function was enough. Moreover, since the acceleration to measure is very large, the acceleration-sensor component which detects acceleration is also manufactured strongly. In order to be used for a personal digital assistant device, a robot, etc. more often and to detect a motion of space recently, X, Y, and 3 shaft acceleration sensor that measures the acceleration of the Z-axis have been required. Moreover, in order to detect minute acceleration, the small thing is demanded by the high resolution.
[0003]
acceleration is the approach of changing a motion of the flexible section into an electrical signal, and is divided roughly into a piezoresistance mold, an electrostatic-capacity mold, and a piezo-electric mold -- having -- the magnitude of the output of a sensor, and response frequency characteristics -- -proof -- electromagnetism -- it is chosen in consideration of detection of a noise, the linearity of an output, and quiescence acceleration, the temperature characteristic, etc. The piezoresistance mold 3 shaft acceleration sensor which is small, uses photolithography for a silicon substrate from the demand of high sensitivity since micro processing is required, forms a configuration, drives an impurity into silicon by semiconductor technology, and forms a piezoresistance has been put in practical use.
[0004]
The enlarged drawing of an acceleration-sensor component is shown in drawing 6 a. The acceleration-sensor component 1 consists of housings 12 supporting the flexible section 13 supporting the spindle section 11, and the flexible section 13, and

the piezoresistive element 9 is formed in the flexible section 13. The piezoresistive element is connected to the terminal 14 with the circuit pattern 31. A motion of the spindle section when an acceleration-sensor component receives external force, and the flexible section is shown in d from drawing 6 b using the k-k' cross section of drawing 6 . The external force of drawing 6 b is in the condition that the flexible section 13 is almost level, in the condition of not being added. The corner location of the spindle section at this time is set to A0. Drawing 6 c expresses typically the configuration of the spindle section and the flexible section when external force is added from the longitudinal direction of an acceleration-sensor component. While is moved to right and left, downward the flexible section bends, another side bends upwards, resistance of a piezoresistive element changes, and the spindle section is detected as an electrical potential difference according to the acceleration of X shaft orientations and Y shaft orientations. The corner location of the spindle section at this time is set to A1. Drawing 6 d expresses typically the configuration of the spindle section and the flexible section when external force is added [of an acceleration-sensor component] from the upper and lower sides. The corner location of the spindle section at this time is set to A2. The flexible section on either side bends in the same direction, and can detect the acceleration of Z shaft orientations. Although decided by the dimension and the impressed acceleration of the flexible section, when an acceleration-sensor component takes 2000G, the location of about 40 micrometers, and A0 and A2 will be as large as about 25 micrometers, and the location of A0 and A1 will be changed.

[0005]

Since the sensibility of an acceleration-sensor component is decided by the ease of bending of the flexible section, it improves, so that the die length of the flexible section is long, width of face is narrow and thickness is thin. Therefore, in the high sensitivity article, the die length of the flexible section is very as thin [500-700 micrometers and width of face / 80-120 micrometers and thickness] as 5-10 micrometers. For this reason, it will break, if the flexible section formed with silicon transforms about 20 micrometers, and the function as an acceleration-sensor component will be lost. Raising the sensibility of an acceleration sensor and the upper limit of the acceleration which can be measured will conflict. In order to use an acceleration sensor for a pocket device etc. and to have enabled it to bear a fall impact, the sensibility of an acceleration sensor had to be lowered.

[0006]

In order to obtain the acceleration sensor which can bear a fall impact by high sensitivity, forming the regulation plate for stopping compulsorily the amount by which the spindle section moves is performed. The approach the rigid plastic diameter of sphere kneaded by the structure and adhesives which added the regulation plate regulates gap g″ of the spindle section 11 and the inner bottom of a protective case and gap g' of the spindle section and the regulation plate 33 is indicated by JP,4-274005,A and JP,8-233851,A. drawing 6 a) The cross-section structure of the acceleration sensor which regulated the motion of the spindle section to b is shown. The regulation plate 33 is formed in the upper and lower sides of the acceleration-sensor component 1, and the spacing g1 and g2 of the regulation plate 33 and the spindle section 11 is regulated by the thickness of a binder 7. The rigid plastic ball equivalent to spacing g1 and g2 contains adhesives 7 in order to control thickness. Each structure currently indicated is a sectional view near the acceleration-sensor component section, and the publication of the wire which performs electrical installation of a piezoresistive element and a protective case is omitted. In order to obtain the acceleration sensor which can bear a fall impact by high sensitivity, many structures which prepared the regulation version are adopted.

[0007]

The development view of the conventional acceleration sensor is shown in drawing 4 . In drawing 4 , the piezoresistive element (not shown) of the acceleration-sensor component 1 is connected to the terminal 14 of an acceleration-sensor component with the circuit pattern 31. It connects with the terminal 5 of a protective case 2 with a wire 4, and the terminal 14 of an acceleration-sensor component is connected to the external terminal 6. The regulation plate 33 has fixed with adhesives (not shown) through the spacer (not shown) so that a predetermined gap may be maintained at the housing section of an acceleration sensor. The acceleration-sensor component 1 has fixed with adhesives (not shown) through the spacer (not shown) so that an acceleration-sensor component and an inner bottom may maintain a predetermined gap at the inner bottom of a protective case 2. Fixing seal of the protective case lid 3 is carried out at a protective case 2, and the acceleration sensor 10 is constituted.

[0008]

The j-j' cross section of drawing 4 is shown in drawing 5 . The acceleration-sensor component 1 consists of the spindle section 11, and a housing 12 and the flexible section 13. The piezoresistive element (not shown) and the circuit pattern 31 (not shown) are formed in the wire 4 connection side of the flexible section 13. A circuit pattern 31 and a terminal 14 are formed in housing 12 top face, and the terminal 14 and the terminal 5 are connected with the wire 4. The inner bottom, a housing and a housing, and regulation plate of a protective case 2 fix with the resin adhesives 7 which kneaded the hard PURACHIKKU ball. The rigid plastic diameter of sphere kneaded by adhesives regulates gap g″ of the spindle section 11 and the inner bottom of a protective case, and gap g' of the spindle section and the regulation plate 33. This gap g' and when too much acceleration joins an acceleration sensor, g″ regulates the amount of motions of the spindle section, and prevents breakage of the flexible section 13. The protective case 2 and the protective case lid 3 have fixed by adhesives 7'. If external force joins an acceleration-sensor component, the spindle section 11 hung by the flexible section 13 will move, the flexible section 13 will be sagged, the amount of bending will be sensed by the piezoresistive element, and it will output as an electrical potential difference.

[0009]

[Problem(s) to be Solved by the Invention]

When fixing the regulation plate 33 of an abbreviation rectangle by the resin which kneaded the rigid plastic ball to the housing, even if a wire not only becomes obstructive, but uses the wire of a path thinner than a gap, it is not avoided that the connection climax height when carrying out ultrasonic welding of the wire to a terminal becomes larger than a gap. In order to avoid the climax section of the path of a wire, or a connection, it is necessary to make a regulation plate smaller

than the inner field surrounded with a terminal 32. However, in order to obtain the bond strength of a regulation plate, adhesion area needed to be enlarged, therefore the dimension of a housing became large, and there was a problem referred to as it not only checking a miniaturization, but the number of the acceleration-sensor components which can be taken from a wafer decreasing, and pushing up a price. Moreover, since an acceleration-sensor component was miniaturized, making the appearance of an acceleration-sensor component small, applying resin on a circuit pattern, fixing a regulation plate, and also enlarging adhesion area was also performed, but the circuit pattern side had the trouble referred to as the rigid plastic in resin damaging a circuit pattern, or disconnecting a regulation plate if it works to Mr. resin ******** strongly, in order for Gap g to become unstable since it is irregular, or to obtain Gap g.

[0010]

It is made in order that this invention may solve the above-mentioned trouble, and management and connection of a wire are easy and it aims at offering a shock-proof high acceleration sensor cheaply by small [with the regulation plate with which the adhesion area and the stable gap of a regulation plate are obtained], and high sensitivity.

[0011]

[Means for Solving the Problem]

The acceleration sensor of this invention is an acceleration sensor to which it became from a regulation plate, a protective case, etc. which regulate a motion of the flexible section, the spindle section, and the spindle section of the acceleration-sensor component which consists of a housing, and the acceleration-sensor component and the terminal of a protective case were connected with the wire, and is characterized by having prepared the notching section in fields other than the four-corners section of a regulation plate, and preventing contact of a wire and a circuit pattern, and a regulation plate.

[0012]

If the reservation and reinforcement of a part which a regulation plate counters with jointing and the spindle section are obtained, the dimension of the notching section and especially a configuration will not be asked. The weight of a regulation plate can be lowered by enlarging the notching section as much as possible. It leaves the corner of the regulation plate material of an abbreviation rectangle, and the regulation plate which has the part which counters jointing and the spindle section by preparing the notching section in a part of each side is obtained. The notching section can use a rectangle or a hemicycle, polygons, and those combination. The notching depth can be changed on the front reverse side of a regulation plate, and it can also consider as the structure of having an inclined plane. When it sees from an applying-to top face of terminal which connects wire-regulation plate, i.e., regulation plate, side, it is more desirable to prepare the notching section so that a terminal may appear.

[0013]

Glass, and a ceramic and a metal can be used for the quality of the material of a regulation plate. When external force is added, unless a regulation plate deforms easily, there is no constraint in a material selection. In order to attain lightweight-ization of the whole acceleration sensor, it is desirable to choose an ingredient with small specific gravity. When unusual acceleration is added, what are displaced greatly is the spindle section and the flexible section near the ****. Since it may connect too hastily electrically with the acceleration-sensor component with which the circuit pattern was formed not only in the flexible section but in the spindle section if a metaled regulation plate is used, it is desirable to use insulating glass and an insulating ceramic. In the case of the acceleration-sensor component by which the circuit pattern of the flexible section or the spindle section was protected by the insulator layer, a metaled regulation plate can also be used.

[0014]

The same material as the thickness of a regulation plate can be manufactured by machining, chemical etching, etching using vacuum devices, etc. for example, the thing which a photoresist is applied to a glass plate and done for chemical etching using fluoric acid — easy — as — lacking — the section — having — regulation — a plate — it can manufacture . Carrying out grinding of glass or the ceramic plate with a diamond grinding stone is also acquired easily. After forming the notching section using a material thicker than the thickness of a regulation plate, cutting and grinding may be performed so that it may become the thickness of a regulation plate, but since it will become high in price, it is not a not much desirable approach.

[0015]

As for the acceleration sensor of this invention, it is desirable to fix the four-corners section of a regulation plate through a spacer to the field in which the circuit pattern and terminal of a housing of an acceleration-sensor component are not formed.

[0016]

It is desirable to paste up jointing of a part without the terminal and circuit pattern of housing four corners and a regulation plate through a spacer. Gap g will be obtained if it pastes up on a terminal and the circuit pattern section. If the regulation plate which has the notching section of this invention is used, even if a binder adheres on a terminal and a circuit pattern, since there is a notching section field, and a predetermined value is acquired, as for Gap g, spreading of a binder will become easy.

[0017]

Since the notching section is prepared so that a terminal may appear when it sees from an applying-to top face of terminal which connects wire-regulation plate, i.e., regulation plate, side, the degree of freedom of management of a wire can use a wire thicker than Gap g, and it not only becomes large, but can lower electric resistance. Moreover, since the amount of climaxes of the connection of a wire is also permitted, it is not necessary to carry out the ultrasonic bonding of the expensive golden wire, and it also becomes possible to solder copper wire.

[0018]

An acceleration-sensor component top face and the gap g of a regulation plate can obtain a rigid plastic ball, a ceramic ball, and a bulb to resin by being what was kneaded about 10% and fixing from several %, by weight. In order to attain lightweight-ization of an acceleration sensor, it is desirable to use a rigid plastic with small specific gravity. To resin, the gap g of an

acceleration-sensor component inferior surface of tongue and the bottom within a protective case is what kneaded the rigid plastic ball, the ceramic ball, the metal ball, and the bulb about 10% from several % by weight, and can be fixed. Since there is neither a circuit pattern nor a terminal in an acceleration-sensor inferior surface of tongue, and it is not necessary to take an electric insulation into consideration, a cheap metal ball can also be used.

[0019]

[Embodiment of the Invention]

The example of the acceleration sensor of this invention is explained using drawing 1 and 2. The same sign is used for the same components as the conventional example in order to give explanation intelligible. Drawing 1 is the development view of the acceleration sensor of this invention, drawing 2 a is a h-h' sectional view, drawing 2 b is the perspective view of the used regulation plate, and the four notching sections 23 are formed. In drawing 1 , it connects with the terminal 5 of a protective case 2 with a wire 4, and the terminal 14 of the acceleration-sensor component 1 is connected to the external terminal 6. Fixing seal of fixing and the protective case lid 3 was carried out at the protective case 2 using the adhesives 7 with which the rigid plastic ball was kneaded by the acceleration-sensor component top face in the regulation plate 21, and the acceleration sensor was formed. Regulation of a motion of the direction of a component inferior surface of tongue of the spindle section used the inner bottom of a protective case 2, and was made into the structure which the bottom within a protective case and the housing inferior surface of tongue fixed using the adhesives 7 with which the rigid plastic ball was kneaded. Moreover, illustration of a piezoresistive element is omitted. Close [of a rigid plastic ball] fixed the protective case 2 and the protective case lid 3 by resin 7' which is not.

[0020]

The manufacture approach of a piezoresistive element and dimension relation are explained briefly. The SOI wafer which has a micrometers [several] silicon oxidizing zone and an about 10-micrometer silicon layer was used for the silicon plate of about 600-micrometer thickness. Wiring which connects boron to a patterning deed silicon layer, and connects 1 - 3x1018 atom / cm3 placing piezoresistive element to production and a piezoresistive element was formed using the metal spatter and the dry etching system by the photoresist. FOTORISO and a dry etching system were used and the flexible section, the spindle section, and a housing were formed in the silicon layer. Since a silicon oxidizing zone serves as an etching stopper, only a silicon layer is etched. The piezo-electric element side was turned down, the SOI wafer was pasted up on the dummy substrate, and about 600 micrometers of a silicon plate were etched within the plasma which introduced SF6 and oxygen. After the cutting machine separated into the chip the substrate with which the flexible section, the spindle section, and a housing were formed, adhesion resin was melted using the solvent and the acceleration-sensor component was removed from the dummy substrate. In order to obtain a high sensitivity acceleration sensor, the dimension of the flexible section is die length of 700 micrometers, width of face of 110 micrometers, the thickness of 6 micrometers, and a very thin monotonous thing. As for the width of face of 1000 micrometers and a housing, the spindle section sets die length of one side to 450 micrometers, and the acceleration-sensor component appearance configuration is made into 3.3mm angle thickness of about 0.6mm. Since the conventional acceleration-sensor component used for the comparison needed to make width of face of a housing large with 750 micrometers, the acceleration-sensor component appearance configuration serves as 3.9mm angle thickness of about 0.6mm.

[0021]

After fixing an acceleration-sensor component with adhesives 7 to a protective case 2 in 10 micrometers of gaps, the terminal 14 of an acceleration-sensor component and the terminal 5 of a protective case 2 were connected with the wire 4. a wire -- phi25micrometer nakedness -- it welded by the ultrasonic bonder using the gold streak. Management of a wire is made as small as possible. Before adding a regulation plate, the amount h1 of wire climaxes of a terminal area and the management height h2 of a wire were measured. Adhesives were applied to the four corners of an acceleration-sensor component, after fixing the regulation plate 21 which has the notching section 23 in 8 micrometers of gaps, the protective case lid 3 was fixed by adhesives 7', and the acceleration sensor was obtained. In adhesives 7' used for adhesion of a protective case 2 and a protective case lid, the rigid plastic ball used as a spacer is not kneaded.

[0022]

It rises to drawing 8 and an amount h1 and the wire management height h2 are shown. a terminal -- a wire -- an ultrasonic-bonding line -- since a wire is held down for a terminal by the unacquainted ultrasonic wedge tool, the edge of a wire rises. It will rise, if distance of an ultrasonic wedge tool and a wire edge is not especially made below into a wire gage, and an amount h1 will become large. The height from the terminal side by the side of the edge of a wire prescribed the amount of climaxes. The management height h2 of a wire will mainly be decided by the rigidity of a wire gage, i.e., a wire. Even when connecting a wire linearly, it manages substantially from the core set of a wire etc., and height h2 arises.

[0023]

200 combination B of the acceleration-sensor component of combination A of the small acceleration-sensor component of **, the regulation plate 33 of the rectangular plate of the former for a comparison, and 3.9mm angle was respectively manufactured outside the regulation plate 21 which has the notching section of this invention, and 3.3mm angle. A and B of the amount h1 of climaxes were 30 to 50 micrometers. A and B of the wire management height h2 were 100 to 270 micrometers. Distribution of h1 and h2 is carrying out normal distribution, and did not almost have a difference at A and B. When the adhesion working hours of a regulation plate were investigated, since A worked without caring about a wire management condition, compared with B, compaction of about 20% of working hours of it was completed.

[0024]

The acceleration of 5G, 10G, and 20G was given to the acceleration sensor of A and B, the output and the noise level were measured, and generating of a defective did not have each-other gap, either. After these trials, the plate with a thickness of 100mm was made to carry out natural fall of the acceleration sensor from height of 1m, and shock resistance was measured. If it is made to fall from this height, the impact of 2000G will join an acceleration sensor from about 1500. The output at the time of acceleration impression and the noise level were used as the excellent article going into the specification value.

Shock resistance was judged by whether there is any output after fall, and the acceleration sensor without an output judged with having destroyed, and judged the thing with an output to be an excellent article. It was checked that 200 of A have that of the output after an impact test and a noise level, and it is satisfactory to shock resistance. [the same as that of impact test before] Among 200 of B, after the impact test, three pieces were looked at by two pieces at an output and one piece, and abnormalities were looked at by the noise level. When three abnormal acceleration sensors were decomposed and investigated, each abnormality article in an output was damaged in the boundary section of the flexible section and the spindle section. As for the abnormality article in a noise level, the crack was accepted in the flexible section and the boundary section of a directions frame. When the cause of breakage and a crack was investigated in the detail, the gap g of a regulation plate and the spindle section was larger [a setup] than 8 micrometers. Since two damaged pieces had become a 12-micrometer gap, the motion of the spindle section became large by the impact test, and breakage and a crack generated one of 14 micrometers and a crack for them. The cause which enlarged Gap g was because resin was flowing in on the circuit pattern. As a result of conducting decomposition investigation of the 50 acceleration sensors with shock resistance, even if they were working having managed the amount and spreading location of resin severely, it turned out that it generates in several% of acceleration sensor. Although resin was accepted on the circuit pattern by one piece among 50 pieces, since there was no rigid plastic resin bead used as a spacer into the resin, it is thought that fault did not come out of it by the impact test since Gap g was kept at 8 micrometers.

[0025]

100 acceleration sensors were respectively produced using the regulation plate shown in d from drawing 3 a, and workability, an output, a noise level, and shock resistance were examined. The configuration which drawing 7 a made the notching section deep, and made the intersection rectangle of a cross joint the same dimension as the spindle section, the configuration where drawing 7 b established the curved surface in the slitting section, the configuration where drawing 7 c formed the inclination on the front reverse side of the slitting section, and drawing 7 d are configurations which have the two-step slitting section. The test result was the same as the example mentioned above, and there were not an output, a noise level, and an acceleration sensor that becomes poor with shock resistance. Moreover, compared with the former, assembly-operation time amount has been shortened about 20% like [workability] the above-mentioned example.

[0026]

Next, the order of adhesion of wire connection and a regulation plate was replaced, and the effectiveness of a regulation plate of having the notching section was examined. By pasting up a regulation plate before wire connection after the process which pastes up an acceleration-sensor component on the bottom within a protective case, since the process which stiffens resin is made to coincidence, a hardening routing can be reduced once. However, with the regulation plate of the conventional structure, the regulation plate contacted [the wedge tool of an ultrasonic bonder], and it was not only difficult to connect with a terminal certainly, but since there was much constraint, it was easily unrealizable [the wire] to management of a wire. Wire connection was made after fixing to a housing the regulation plate of this invention shown in drawing 3 a. Since the notching section was prepared in the regulation plate, the wedge tool of an ultrasonic bonder was able to weld the wire to the terminal certainly in the regulation plate. Moreover, since there is the notching section, the degree of freedom of management of a wire very becomes easy to do a riser activity. By the decrease of the count of a hardening routing, and the ease of doing of an activity, assembly-operation time amount has been shortened about 30% to the conventional activity man day.

[0027]

[Effect of the Invention]

By using the regulation plate which prepared the notching section in the part except jointing of four corners, it did not care about management of a wire, but the regulation plate could be fixed to the housing, and about 20 to about 30% of working-hours compaction was attained compared with the conventional regulation plate. The acceleration-sensor element number which an acceleration-sensor component can be made small and can be taken from a wafer by using the regulation plate which has the notching section increased. Moreover, even if adhesion of resin was on the circuit pattern, the gap g of a regulation plate and the spindle section could be secured easily, and the acceleration sensor of the high shock resistance in small and high sensitivity has been offered cheaply.

[Brief Description of the Drawings]

[Drawing 1] It is the development view of the acceleration sensor of this invention.

[Drawing 2] It is the sectional view of the acceleration sensor of this invention.

[Drawing 3] It is the perspective view of the regulation plate in which other examples of this invention are shown.

[Drawing 4] It is the development view of the conventional acceleration sensor.

[Drawing 5] It is the sectional view of the conventional acceleration sensor.

[Drawing 6] It is drawing explaining a motion of an acceleration-sensor component, the spindle section, and the flexible section.

[Drawing 7] It is the sectional view of the conventional acceleration-sensor component section with a regulation plate.

[Drawing 8] It is drawing explaining the amount of climaxes, and wire management height.

[Description of Notations]

1 Acceleration-Sensor Component, 2 Protective Case, 3 Protective Case Lid,
4 Wire, 5 Terminal, 6 External Terminal, 7, 7' Adhesives,
9 Piezoresistive Element, 10 Acceleration Sensor, 11 Spindle Section, 12 Housing,
13 Flexible Section, 14 Terminal, 21 Regulation Plate, 23 Notching Section,
31 A circuit pattern, 33 Regulation plate.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

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4 Wire, 5 Terminal, 6 External Terminal, 7, 7' Adhesives,
9 Piezoresistive Element, 10 Acceleration Sensor, 11 Spindle Section, 12 Housing,
13 Flexible Section, 14 Terminal, 21 Regulation Plate, 23 Notching Section,
31 A circuit pattern, 33 Regulation plate.

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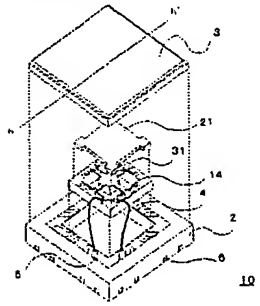
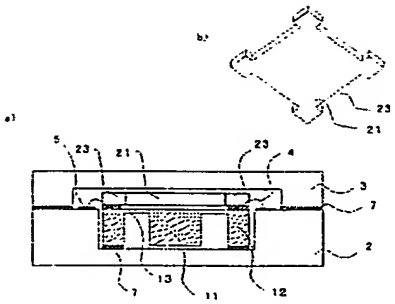
DRAWINGS

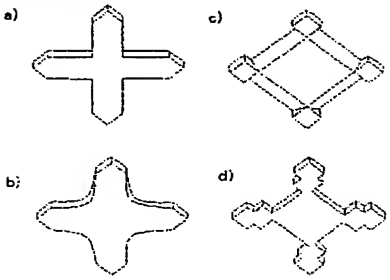
[Drawing 1]



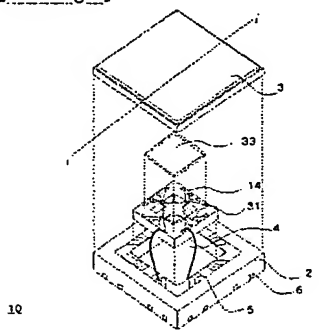
[Drawing 2]



[Drawing 3]



[Drawing 4]



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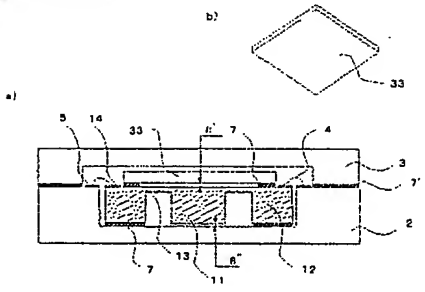

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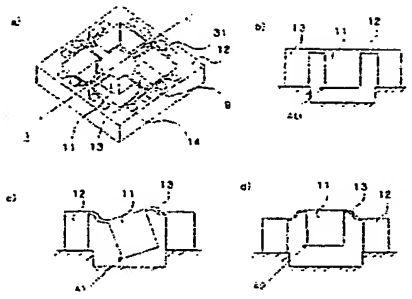

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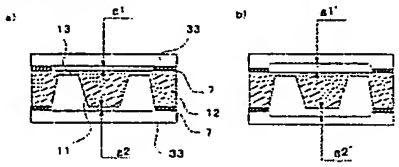
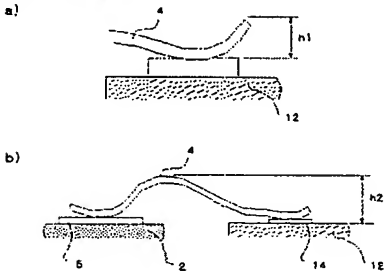


[Drawing 8]



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